TARMAC to the contact patch

How it Works - Tyre/Road Contact Patch Information

TARMAC to the contact patch

TARMAC is a word used around the world to describe the roads we use to get around, the runways used to fly off on holidays or by F1 TV commentators talking about tyre selection. The public think of pot-holes and traffic jams. Pilots are concerned about getting aircraft stopped in wet conditions due to rubber building up on the runway. In contrast, F1 commentators frequently refer to the tarmac being green until race teams see the benefit of laying down rubber to improve lap times. Whilst the black stuff used to build roads, runways and tracks looks the same to most people, calling it TARMAC is wrong.

TARMAC is an abbreviation of two words – tar and macadam - and dates from the start of the 19th century when coal was burnt to produce gas for electricity and heating created TAR as a waste. As quantities increased it was used to bind together the macadam stone layers used to build roads. MACADAM comes from John Loudon Macadam, a Scottish engineer who gave his name back in the early 19th century to the principle of building roads using layers of stone of different sizes. This was the basis of modern road design where a binder is used to hold aggregate particles together and give the road specific engineering characteristics.

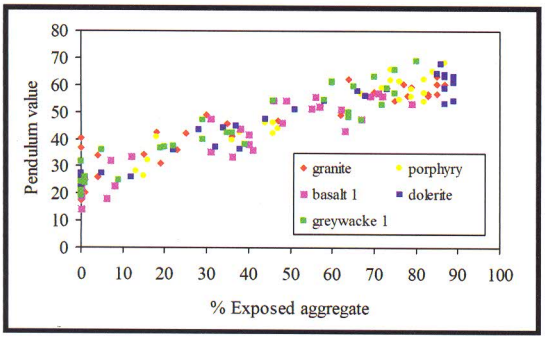
The availability of tar and Macadam's design principles led to the widespread use of TARMAC in road construction. However, TAR has not been used to build roads for many years and is now considered a contaminated waste and if found during road works needs to be carefully managed. TAR as a road binder was replaced by BITUMEN which was created as a by-product in the distillation of crude oil with the advent of the internal combustion engine.

TARMAC was replaced by BITMAC as a generic descriptive term. More recently, European harmonisation of standards and terms used to describe construction products has seen the word ASPHALT adopted to describe any combination of stone and bitumen used to construct roads and other paved areas such as runways and tracks.

ASPHALT is typically black and is laid and compacted in layers to build a road. This layered, composite structure is typically designed to last at least 50 years. The different layers have specific engineering properties to dissipate applied trafficking loads down through its structure.

The surface layer is what people see. It is designed to have additional properties such as wet grip; and address issues such as noise, rolling resistance and spray. Aggregate with good skid resistance for roads may be transported considerable distances.

There are no suitable rocks in the SE of England that have the required properties and has prompted the widespread importation of aggregate from other parts of the UK. It has also prompted the widespread recycling of many road surface materials. Suitable aggregate may even be shipped from England to create the surface of race tracks such as Yas Marina.



Laboratory prediction of wet skid resistance increasing due to bitumen removal exposing the aggregate

Bitumen can be modified to make it stick better to the road surface aggregate particles. Exposure to the sun, heat, cold, water and oxygen will change its

An ASTM friction measuring tyre resting on a cut section of asphalt.

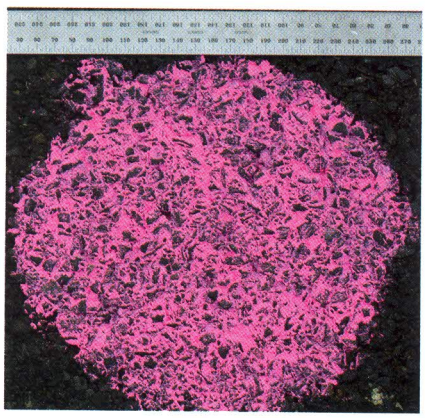
properties. Varying the combination of aggregate particle sizes and amount of bitumen gives the road surface different types of texture. It may be porous and allow rainwater to disperse through it when it rains so improving wet grip and driving conditions by reducing spray. It may be dense and impervious with a very smooth compacted surface.

Many types of asphalt mix are possible between these two extremes. In the UK and Europe the main types are referred to as Asphalt Concrete, Hot Rolled Asphalt, Stone Mastic Asphalt and Thin Surface Course Systems. Whilst they all provide the same functional characteristics i.e. a smooth uniform surface to drive on, they are distinctly different with respect to their contact patch and how they interact with tyre rubber.

The road, runway or track user interacts with this asphalt surface in what is termed a CONTACT PATCH. The tyre and surface texture envelope one another to form a complex, rapidly changing 3D interface. Fundamentally important, what happens in the CONTACT PATCH is not really well understood. If the driver is excluded, it is a combination of vehicle, tyre and road surface working through this CONTACT PATCH that helps reduce the risk of accidents causing serious injury or death. It's what generates noise making people complain about noisy roads. It's what causes unexpected tyre wear should the wrong tyres be selected for a F1 race.

Driving along in the fast lane on the

How it Works



The tyre road surface contact patch shown using a paint removal technique

motorway contact times between the tyre and aggregate particles are in milliseconds – much faster than the blink of an eye. If it has been raining a wedge of water may build up in front of each tyre lifting it off the surface effectively causing the vehicle to float on a layer of water. As speed increases the need to deal with water in the CONTACT PATCH becomes increasingly important as the consequences can be very serious.

New ASPHALT surfaces will have a layer of bitumen between the rubber and aggregate which takes time to wear away. This can happen quite quickly in the channelised lanes of a busy motorway. However, the use of heavily modified bitumen in ASPHALT mixes used on track tracks can take much longer to wear away as a racing line starts to develop around the track due to how the tyres interact with the ASPHALT.

Whether termed TARMAC, BITMAC or ASPHALT; many years of practical experience, fundamental research and product development has improved and optimised the mixtures of aggregate and binders used in road construction. Surely everything is known about this black stuff we use every day. If all the answers are known then why are there still noisy roads and pot-holes? Why do F1 tyres blister or wear away after just a few laps? In truth all the answers are not known. What happens in the contact patch is not really understood or appreciated.

The world of ASPHALT and the CONTACT PATCH is now going into a period of tremendous speculation and probable change due to autonomous vehicles, changing types of aircraft and ever-increasing development of race cars and bikes. More will be expected by the road, runway or track user making knowledge of what's happening in the CONTACT PATCH much more important.

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Readers may be interested in attending the EIS seminar "Tyre Road Contact' at HORIBA-MIRA on 15 November 2018 when this topic will be discussed further.